

DEPARTMENT OF WATER RESOURCES

ENVIRONMENTAL SERVICES OFFICE
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May 17, 1999

Ms. Pat Brandes
U. S. Fish and Wildlife Service
4001 North Wilson Way
Stockton, California 95205

Dear Ms. Brandes:

Subject: Coleman Hatchery Late-Fall Delta Survival Index Calculation

Due to the repercussions from revising the December 29, 1998, Georgiana Slough Delta juvenile Chinook survival experiment results, I investigated the components of that survival calculation. I understood a juvenile Chinook recovered on March 14, 1999, from the Georgiana Slough (released December 29, 1998), increased the relative interior Delta survival (Georgiana Slough/Ryde survival index ratio) quite a bit, from 3.7 to 7.2. I understood this recovery was an "outlier". I investigated the individual recoveries and the sampling effort throughout the recovery period and found the method used to expand the sampling effort can effect the survival index estimate.

The current sampling effort time expansion used by the U.S. Fish & Wildlife Service is the total minutes sampled from the first to last day of recovery, divided by the total minutes from the first to last day of recovery. This expansion would be appropriate if the sampling effort was consistent throughout the recovery period. But, in most Coleman late-fall Delta juvenile Chinook survival experiments, the sampling effort changes throughout the long recovery period. The effort is high for the first couple of weeks and then the effort is reduced. The method could be appropriate, even if the sampling effort changed, if we could assume the juvenile Chinook were available for recovery at a consistent density (and assuming consistent catchability). In most cases we don't make this assumption. If we assume the juveniles recovered toward the end of a long recovery period occur at a lower density, then using the average time expansion from the first to last day of recovery overestimates the individuals recovered at the higher effort, and underestimates the individuals recovered at the lower effort. The effect on survival index varies among experiments depending on the daily recoveries.

I suggest an alternative method to calculate a sampling effort time expansion based on a shorter time scale. The time scale could be as short as from one sampling event to the next (the method used at the salvage facilities), or at the most, the average within discrete sampling efforts. I calculated a Delta juvenile survival index for the late-December 1998, Georgiana Slough and Ryde releases using the alternative method

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based on a sampling event time scale, and compared the results to the USF&WS method. The results are listed below.

Sampling Effort Time Expansion by:

	<u>Sampling Event</u>	<u>Average Throughout Recoveries</u>
Georgiana Slough release	0.2825	0.26
Ryde release	0.4585	0.37
Ratio	0.6161	0.71

Surprisingly, the Georgiana Slough release survival index did not change much between the two methods; the Ryde survival index changed more.

Although I did not expect large changes in most of the survival indexes, I asked Erin Chappell to calculate all ten of the Delta juvenile late-fall Chinook experiments using the two methods (Tables 1-10). I examined the differences between the two methods to expand the sampling effort, and the resulting relationships with environmental parameters, particularly, combined exports.

The calculated survival indexes and Georgiana Slough/Ryde ratios expanding sample effort by sample event and experimental average are listed below.

Mo./Yr.	Georgiana Slough		Ryde		Ratio	
	Smpl. Evnt.	Exp. Avg.	Smpl. Evnt.	Exp. Avg.	Smpl. Evnt.	Exp. Avg.
12/93	0.18	0.27**	1.09	1.89**	0.1632	0.1443
12/94	0.15	0.15	0.58	0.57	0.2522	0.2722
1/95	0.06	0.06	0.38	0.38	0.1548	0.1549
1/96	0.18	0.17	0.65	0.65	0.2716	0.2578
12/97	0.03	0.03	0.47	0.67**	0.0645	0.0468
1/98	0.25	0.26	0.92	0.93	0.2694	0.2750
12/98a	0.15	0.17	0.59	0.69**	0.2601	0.2476
12/98b	0.28	0.26	0.46	0.37**	0.6161	0.7088**

** Largest changes due to sampling time expansion.

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The largest differences between survival indexes or survival ratios are noted by an **. For four of the five largest differences, the experimental average sampling effort expansion overestimated the survival index or ratio. For one of the five largest differences, the experimental average sampling effort expansion underestimated the survival index.

The USF&WS found a relationship between relative interior Delta survival (Georgiana Slough/Ryde survival index ratio) and average exports. The r-squared was .46 and p was 0.6. Using the sampling effort expansion by sampling event, the relationship with exports still existed, the r-squared was 0.50 and p was 0.5 (Figure 1). The slope did not change much. Relationships between relative interior delta survival and other environmental parameters did not change significantly.

Although the alternative sampling effort expansion, based on sampling effort, did not change the relative interior Delta survival relationships with environmental parameters significantly, I recommend you consider using the alternative method. The sampling effort expansion method currently used by USF&WS has the potential to significantly over or underestimate the survival index.

Sincerely,



Sheila Greene
Ecological Studies Branch
Environmental Services Office

Enclosures

cc: (see attached list)

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**TABLE 1. COLEMAN LATE-FALL CHINOOK RECOVERIES AT CHIPPS ISLAND
DELTA RELEASE - DECEMBER 1993**

DATE	NUM REC G.S.	NUM REC RYDE	TOW TIME (MINS)	TOTAL MINS.	% SAMP	ALTER- NATIVE INDEX G.S.	USFWS INDEX G.S. .0698	ALTER- NATIVE INDEX RYDE	USFWS INDEX RYDE .0724
12/3/93	0	0	197	1440	0.1368	0.0000	0.0000	0.0000	0.0000
12/4/93	0	0	200	1440	0.1389	0.0000	0.0000	0.0000	0.0000
12/5/93	0	0	200	1440	0.1389	0.0000	0.0000	0.0000	0.0000
12/6/93	0	1	200	1440	0.1389	0.0000	0.0000	0.0266	0.0511
12/7/93	0	4	200	1440	0.1389	0.0000	0.0000	0.1066	0.2044
12/8/93	0	0	200	1440	0.1389	0.0000	0.0000	0.0000	0.0000
12/9/93	0	4	200	1440	0.1389	0.0000	0.0000	0.1066	0.2044
12/10/93	0	0	200	1440	0.1389	0.0000	0.0000	0.0000	0.0000
12/11/93	0	4	200	1440	0.1389	0.0000	0.0000	0.1066	0.2044
12/12/93	1	5	200	1440	0.1389	0.0274	0.0546	0.1332	0.2555
12/13/93	1	5	200	1440	0.1389	0.0274	0.0546	0.1332	0.2555
12/14/93	0	0	200	1440	0.1389	0.0000	0.0000	0.0000	0.0000
12/15/93	0	4	200	1440	0.1389	0.0000	0.0000	0.1066	0.2044
12/16/93	0	3	200	1440	0.1389	0.0000	0.0000	0.0799	0.1533
12/17/93	1	0	200	1440	0.1389	0.0274	0.0546	0.0000	0.0000
12/18/93	0	1	200	1440	0.1389	0.0000	0.0000	0.0266	0.0511
12/19/93	1	1	200	1440	0.1389	0.0274	0.0546	0.0266	0.0511
12/20/93	0	1	200	1440	0.1389	0.0000	0.0000	0.0266	0.0511
12/21/93	0	0	200	1440	0.1389	0.0000	0.0000	0.0000	0.0000
12/22/93	0	1	200	1440	0.1389	0.0000	0.0000	0.0266	0.0511
12/23/93	0	0	200	3600	0.0556	0.0000	0.0000	0.0000	0.0000
12/24/93	*	*	*	*	*	*	*	*	*
12/25/93	*	*	*	*	*	*	*	*	*
12/26/93	*	*	*	*	*	*	*	*	*
12/27/93	0	1	200	4320	0.0463	0.0000	0.0000	0.0799	0.0511
12/28/93	*	*	*	*	*	*	*	*	*
12/29/93	0	0	200	2160	0.0926	0.0000	0.0000	0.0000	0.0000
12/30/93	0	1	200	3600	0.0556	0.0000	0.0000	0.0666	0.0511
12/31/93	*	*	*	*	*	*	*	*	*
1/1/94	*	*	*	*	*	*	*	*	*
1/2/94	*	*	*	*	*	*	*	*	*
1/3/94	0	0	200	4320	0.0463	0.0000	0.0000	0.0000	0.0000
1/4/94	*	*	*	*	*	*	*	*	*
1/5/94	0	0	200	2880	0.0694	0.0000	0.0000	0.0000	0.0000
1/6/94	*	*	*	*	*	*	*	*	*
1/7/94	0	0	200	3600	0.0556	0.0000	0.0000	0.0000	0.0000
1/8/94	*	*	*	*	*	*	*	*	*
1/9/94	*	*	*	*	*	*	*	*	*
1/10/94	0	0	200	3600	0.0556	0.0000	0.0000	0.0000	0.0000
1/11/94	*	*	*	*	*	*	*	*	*
1/12/94	0	0	200	2880	0.0694	0.0000	0.0000	0.0000	0.0000
1/13/94	*	*	*	*	*	*	*	*	*
1/14/94	0	0	175	4320	0.0405	0.0000	0.0000	0.0000	0.0000

DATE	NUM REC G.S.	NUM REC RYDE	TOW TIME (MINS)	TOTAL MINS.	% SAMP	ALTER- NATIVE INDEX G.S.	USFWS INDEX G.S. .0698	ALTER- NATIVE INDEX RYDE	USFWS INDEX RYDE .0724
3/2/94	0	0	200	2880	0.0694	0.0000	0.0000	0.0000	0.0000
3/3/94	*	*	*	*	*	*	*	*	*
3/4/94	1	0	200	3600	0.0556	0.0685	0.0546	0.0000	0.0000
3/5/94	*	*	*	*	*	*	*	*	*
3/6/94	*	*	*	*	*	*	*	*	*
3/7/94	0	0	200	3600	0.0556	0.0000	0.0000	0.0000	0.0000
3/8/94	*	*	*	*	*	*	*	*	*
3/9/94	0	0	196	2880	0.0681	0.0000	0.0000	0.0000	0.0000
3/10/94	*	*	*	*	*	*	*	*	*
3/11/94	0	0	200	4320	0.0463	0.0000	0.0000	0.0000	0.0000
3/12/94	*	*	*	*	*	*	*	*	*
3/13/94	*	*	*	*	*	*	*	*	*
3/14/94	*	*	*	*	*	*	*	*	*
3/15/94	0	0	200	3600	0.0556	0.0000	0.0000	0.0000	0.0000
3/16/94	0	1	200	2160	0.0926	0.0000	0.0000	0.0400	0.0511
3/17/94	*	*	*	*	*	*	*	*	*
TOTAL	5	37	11130	150480	0.0740	0.1782	0.2728	1.0922	1.8909

**TABLE 2. COLEMAN LATE-FALL CHINOOK RECOVERIES AT CHIPPS ISLAND
DELTA RELEASE - DECEMBER 1994**

DATE	NUM REC G.S.	NUM REC ISLE	TOW TIME (MINS)	TOTAL MINS	% SAMP	ALTER- NATIVE INDEX G.S.	USFWS INDEX G.S. .1053	ALTER- NATIVE INDEX ISLE	USFWS INDEX ISLE % SAMP .1122
12/5/94	0	0	200	1440	0.1389	0.0000	0.0000	0.0000	0.0000
12/6/94	0	0	200	1440	0.1389	0.0000	0.0000	0.0000	0.0000
12/7/94	0	0	200	1440	0.1389	0.0000	0.0000	0.0000	0.0000
12/8/94	0	0	200	1440	0.1389	0.0000	0.0000	0.0000	0.0000
12/9/94	0	0	200	1440	0.1389	0.0000	0.0000	0.0000	0.0000
12/10/94	0	0	200	1440	0.1389	0.0000	0.0000	0.0000	0.0000
12/11/94	0	4	200	1440	0.1389	0.0000	0.0000	0.1222	0.1512
12/12/94	0	0	200	1440	0.1389	0.0000	0.0000	0.0000	0.0000
12/13/94	0	1	200	1440	0.1389	0.0000	0.0000	0.0305	0.0378
12/14/94	0	2	200	1440	0.1389	0.0000	0.0000	0.0611	0.0756
12/15/94	0	1	200	1440	0.1389	0.0000	0.0000	0.0305	0.0378
12/16/94	0	2	200	1440	0.1389	0.0000	0.0000	0.0611	0.0756
12/17/94	0	0	199	1440	0.1382	0.0000	0.0000	0.0000	0.0000
12/18/94	0	0	200	1440	0.1389	0.0000	0.0000	0.0000	0.0000
12/19/94	1	0	200	1440	0.1389	0.0293	0.0386	0.0000	0.0000
12/20/94	0	0	200	1440	0.1389	0.0000	0.0000	0.0000	0.0000
12/21/94	0	1	200	1440	0.1389	0.0000	0.0000	0.0305	0.0378
12/22/94	1	0	200	1440	0.1389	0.0293	0.0386	0.0000	0.0000
12/23/94	1	2	200	2880	0.0694	0.0585	0.0386	0.1222	0.0756
12/24/94	*	*	*	*	*	*	*	*	*
12/25/94	*	*	*	*	*	*	*	*	*
12/26/94	0	0	200	2880	0.0694	0.0000	0.0000	0.0000	0.0000
12/27/94	0	1	100	1440	0.0694	0.0000	0.0000	0.0611	0.0378
12/28/94	0	0	180	1440	0.125	0.0000	0.0000	0.0000	0.0000
12/29/94	0	0	200	1440	0.1389	0.0000	0.0000	0.0000	0.0000
12/30/94	0	0	200	1440	0.1389	0.0000	0.0000	0.0000	0.0000
12/31/94	0	0	200	2880	0.0694	0.0000	0.0000	0.0000	0.0000
1/1/95	*	*	*	*	*	*	*	*	*
1/2/95	*	*	*	*	*	*	*	*	*
1/3/95	0	1	200	2880	0.0694	0.0000	0.0000	0.0611	0.0378
1/4/95	0	0	200	1440	0.1389	0.0000	0.0000	0.0000	0.0000
1/5/95	0	0	200	1440	0.1389	0.0000	0.0000	0.0000	0.0000
1/6/95	1	0	200	1440	0.1389	0.0293	0.0386	0.0000	0.0000
TOTAL	4	15	5679	47520	0.1195	0.1464	0.1544	0.5804	0.5672

TABLE 3. COLEMAN LATE-FALL CHINOOK RECOVERIES AT CHIPPS ISLAND
DELTA RELEASE - JANUARY 1995

DATE	NUM REC G.S.	NUM REC ISLE	TOW TIME (MINS)	TOTAL MINS	% SAMP	ALTER- NATIVE INDEX G.S.	USFWS INDEX G.S. .1389	ALTER- NATIVE INDEX ISLE	USFWS INDEX ISLE .1389
1/4/95	0	0	200	1440	0.1389	0.0000	0.0000	0.0000	0.0000
1/5/95	0	0	200	1440	0.1389	0.0000	0.0000	0.0000	0.0000
1/6/95	0	0	200	1440	0.1389	0.0000	0.0000	0.0000	0.0000
1/7/95	0	0	160	1440	0.1111	0.0000	0.0000	0.0000	0.0000
1/8/95	0	0	200	1440	0.1389	0.0000	0.0000	0.0000	0.0000
1/9/95	0	2	200	1440	0.1389	0.0000	0.0000	0.0585	0.0585
1/10/95	0	5	200	1440	0.1389	0.0000	0.0000	0.1463	0.1462
1/11/95	0	4	200	1440	0.1389	0.0000	0.0000	0.1170	0.1170
1/12/95	1	0	200	1440	0.1389	0.0295	0.0295	0.0000	0.0000
1/13/95	0	1	200	1440	0.1389	0.0000	0.0000	0.0293	0.0292
1/14/95	0	1	200	1440	0.1389	0.0000	0.0000	0.0293	0.0292
1/15/95	0	0	200	1440	0.1389	0.0000	0.0000	0.0000	0.0000
1/16/95	1	0	200	1440	0.1389	0.0295	0.0295	0.0000	0.0000
TOTAL	2	13	2560	18720	0.1368	0.0589	0.0589	0.3803	0.3802

**TABLE 4. COLEMAN LATE-FALL CHINOOK RECOVERIES AT CHIPPS ISLAND
DELTA RELEASE - JANUARY 1996**

DATE	NUM REC COURT	NUM REC G.S.	NUM REC RYDE	TOW TIME (MINS)	TOTAL MINS	% SAMP	ALTR-NTV INDEX COURT	INDEX COURT % .1231	ALTR-NTV INDEX G.S.	INDEX G.S. % .1130	ALTR-NTV INDEX RYDE	USFWS INDEX RYDE % SAMPL .1351
1/9/96	0	0	0	40	1440	0.0278	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1/10/96	0	0	0	200	1440	0.1389	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1/11/96	0	0	0	100	1440	0.0694	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1/12/96	0	0	0	201	1440	0.1396	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1/13/96	0	0	0	200	1440	0.1389	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1/14/96	0	0	0	200	1440	0.1389	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1/15/96	2	0	0	200	1440	0.1389	0.0528	0.0596	0.0000	0.0000	0.0000	0.0000
1/16/96	4	0	0	200	1440	0.1389	0.1056	0.1192	0.0000	0.0000	0.0000	0.0000
1/17/96	6	0	5	200	1440	0.1389	0.1584	0.1787	0.0000	0.0000	0.1514	0.1556
1/18/96	3	0	2	200	1440	0.1389	0.0792	0.0894	0.0000	0.0000	0.0605	0.0622
1/19/96	4	1	3	200	1440	0.1389	0.1056	0.1192	0.0274	0.0337	0.0908	0.0934
1/20/96	0	0	3	200	1440	0.1389	0.0000	0.0000	0.0000	0.0000	0.0908	0.0934
1/21/96	1	0	0	200	1440	0.1389	0.0264	0.0298	0.0000	0.0000	0.0000	0.0000
1/22/96	0	0	3	200	1440	0.1389	0.0000	0.0000	0.0000	0.0000	0.0908	0.0934
1/23/96	0	1	1	140	1440	0.0972	0.0000	0.0000	0.0392	0.0337	0.0432	0.0311
1/24/96	2	1	2	200	1440	0.1389	0.0528	0.0596	0.0274	0.0337	0.0605	0.0622
1/25/96	0	0	1	200	1440	0.1389	0.0000	0.0000	0.0000	0.0000	0.0303	0.0311
1/26/96	0	0	0	200	1440	0.1389	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1/27/96	1	0	1	200	1440	0.1389	0.0264	0.0298	0.0000	0.0000	0.0303	0.0311
1/28/96	0	0	0	200	1440	0.1389	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1/29/96	0	0	0	200	1440	0.1389	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1/30/96	1	0	0	200	1440	0.1389	0.0264	0.0298	0.0000	0.0000	0.0000	0.0000
1/31/96	0	0	0	200	1440	0.1389	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2/1/96	0	0	0	200	1440	0.1389	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2/2/96	0	0	0	200	1440	0.1389	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2/3/96	0	0	0	200	1440	0.1389	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2/4/96	0	0	0	200	1440	0.1389	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2/5/96	0	0	0	180	1440	0.125	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2/6/96	0	0	0	200	1440	0.1389	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2/7/96	1	1	0	200	1440	0.1389	0.0264	0.0298	0.0274	0.0337	0.0000	0.0000
2/8/96	0	0	0	200	1440	0.1389	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2/9/96	0	0	0	200	3600	0.0556	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2/10/96	*	*	*	*	*	*	*	*	*	*	*	*
2/11/96	*	*	*	*	*	*	*	*	*	*	*	*
2/12/96	*	*	*	*	*	*	*	*	*	*	*	*
2/13/96	1	0	0	200	5040	0.0397	0.0924	0.0298	0.0000	0.0000	0.0000	0.0000
2/14/96	*	*	*	*	*	*	*	*	*	*	*	*
2/15/96	*	*	*	*	*	*	*	*	*	*	*	*
2/16/96	0	1	0	200	2880	0.0694	0.0000	0.0000	0.0548	0.0337	0.0000	0.0000
TOTAL	26	5	21	6461	56160	0.115	0.7525	0.7745	0.1762	0.1685	0.6487	0.6535

TABLE 5. COLEMAN LATE-FALL CHINOOK RECOVERIES AT CHIPPS ISLAND
DELTA RELEASE - DECEMBER 1996

DATE	NUM REC MILLER PARK	TOW TIME (MINS)	TOTAL MINS	% SAMP	ALTER- NATIVE INDEX M. P.	USFWS INDEX M. P. % SAMP .1391
12/3/96	0	200	1440	0.1389	0.0000	0.0000
12/4/96	0	200	1440	0.1389	0.0000	0.0000
12/5/96	0	200	1440	0.1389	0.0000	0.0000
12/6/96	0	160	1440	0.1111	0.0000	0.0000
12/7/96	0	200	1440	0.1389	0.0000	0.0000
12/8/96	3	200	1440	0.1389	0.0500	0.0499
12/9/96	1	200	1440	0.1389	0.0167	0.0166
12/10/96	1	200	1440	0.1389	0.0167	0.0166
12/11/96	0	200	1440	0.1389	0.0000	0.0000
12/12/96	7	200	1440	0.1389	0.1166	0.1164
12/13/96	1	203	1440	0.1410	0.0164	0.0166
12/14/96	3	200	1440	0.1389	0.0500	0.0499
12/15/96	2	200	1440	0.1389	0.0333	0.0333
12/16/96	1	200	1440	0.1389	0.0167	0.0166
12/17/96	1	200	1440	0.1389	0.0167	0.0166
TOTAL	20	2963	21600	0.1372	0.3328	0.3326

TABLE 6. COLEMAN LATE-FALL CHINOOK RECOVERIES AT CHIPPS ISLAND
DELTA RELEASE - JANUARY 1997

DATE	NUM REC MILLER PARK	TOW TIME (MINS)	TOTAL MINS	% SAMP	ALTER- NATIVE INDEX M. P.	USFWS INDEX M. P. .1310 %SAMP
1/15/97	0	200	1440	0.1389	0.0000	0.0000
1/16/97	8	200	1440	0.1389	0.1537	0.1630
1/17/97	1	200	1440	0.1389	0.0192	0.0204
1/18/97	0	200	1440	0.1389	0.0000	0.0000
1/19/97	0	200	1440	0.1389	0.0000	0.0000
1/20/97	0	195	1440	0.1354	0.0000	0.0000
1/21/97	0	180	1440	0.1250	0.0000	0.0000
1/22/97	1	200	1440	0.1389	0.0192	0.0204
1/23/97	0	200	1440	0.1389	0.0000	0.0000
1/24/97	0	200	1440	0.1389	0.0000	0.0000
1/25/97	0	200	1440	0.1389	0.0000	0.0000
1/26/97	0	200	1440	0.1389	0.0000	0.0000
1/27/97	0	200	1440	0.1389	0.0000	0.0000
1/28/97	0	200	2160	0.0926	0.0000	0.0000
1/29/97	*	*	*	*	*	*
1/30/97	0	180	2160	0.0833	0.0000	0.0000
1/31/97	0	200	1440	0.1389	0.0000	0.0000
2/1/97	0	200	1440	0.1389	0.0000	0.0000
2/2/97	0	184	1440	0.1278	0.0000	0.0000
2/3/97	0	200	1440	0.1389	0.0000	0.0000
2/4/97	0	200	1440	0.1389	0.0000	0.0000
2/5/97	0	200	1440	0.1389	0.0000	0.0000
2/6/97	0	200	1440	0.1389	0.0000	0.0000
2/7/97	1	200	2880	0.0694	0.0384	0.0204
2/8/97	*	*	*	*	*	*
TOTAL	11	4539	36000	0.1261	0.2305	0.2241

**TABLE 7. COLEMAN LATE-FALL CHINOOK RECOVERIES AT CHIPPS ISLAND
DELTA RELEASE - DECEMBER 1997**

DATE	NUM REC G.S.	NUM REC RYDE	TOW TIME (MINS)	TOTAL MINS	% SAMP	ALTER- NATIVE INDEX G.S.	USFWS INDEX G.S. .1345	ALTER- NATIVE INDEX RYDE	USFWS INDEX RYDE .0907
12/4/97	0	0	200	1440	0.1389	0.0000	0.0000	0.0000	0.0000
12/5/97	0	0	200	1440	0.1389	0.0000	0.0000	0.0000	0.0000
12/6/97	0	0	200	1440	0.1389	0.0000	0.0000	0.0000	0.0000
12/7/97	0	0	180	1440	0.1250	0.0000	0.0000	0.0000	0.0000
12/8/97	0	0	200	1440	0.1389	0.0000	0.0000	0.0000	0.0000
12/9/97	0	0	200	1440	0.1389	0.0000	0.0000	0.0000	0.0000
12/10/97	0	0	200	1440	0.1389	0.0000	0.0000	0.0000	0.0000
12/11/97	0	6	200	1440	0.1389	0.0000	0.0000	0.1185	0.1814
12/12/97	0	1	140	1440	0.0972	0.0000	0.0000	0.0282	0.0302
12/13/97	0	4	200	1440	0.1389	0.0000	0.0000	0.0790	0.1209
12/14/97	0	4	200	1440	0.1389	0.0000	0.0000	0.0790	0.1209
12/15/97	0	1	200	1440	0.1389	0.0000	0.0000	0.0197	0.0302
12/16/97	0	0	200	1440	0.1389	0.0000	0.0000	0.0000	0.0000
12/17/97	0	2	200	1440	0.1389	0.0000	0.0000	0.0395	0.0605
12/18/97	0	0	200	1440	0.1389	0.0000	0.0000	0.0000	0.0000
12/19/97	0	2	200	1440	0.1389	0.0000	0.0000	0.0395	0.0605
12/20/97	0	0	200	1440	0.1389	0.0000	0.0000	0.0000	0.0000
12/21/97	0	0	200	2160	0.0926	0.0000	0.0000	0.0000	0.0000
12/22/97	*	*	*	*	*	*	*	*	*
12/23/97	0	0	200	2160	0.0926	0.0000	0.0000	0.0000	0.0000
12/24/97	0	0	200	2160	0.0926	0.0000	0.0000	0.0000	0.0000
12/25/97	*	*	*	*	*	*	*	*	*
12/26/97	0	0	35	2160	0.0162	0.0000	0.0000	0.0000	0.0000
12/27/97	0	0	190	1440	0.1319	0.0000	0.0000	0.0000	0.0000
12/28/97	0	1	190	1440	0.1319	0.0000	0.0000	0.0208	0.0302
12/29/97	0	0	200	1440	0.1389	0.0000	0.0000	0.0000	0.0000
12/30/97	0	0	198	1440	0.1375	0.0000	0.0000	0.0000	0.0000
12/31/97	0	0	200	2880	0.0694	0.0000	0.0000	0.0000	0.0000
1/1/98	*	*	*	*	*	*	*	*	*
1/2/98	*	*	*	*	*	*	*	*	*
1/3/98	0	0	120	3600	0.0333	0.0000	0.0000	0.0000	0.0000
1/4/98	*	*	*	*	*	*	*	*	*
1/5/98	0	0	200	2880	0.0694	0.0000	0.0000	0.0000	0.0000
1/6/98	*	*	*	*	*	*	*	*	*
1/7/98	0	0	200	2880	0.0694	0.0000	0.0000	0.0000	0.0000
1/8/98	*	*	*	*	*	*	*	*	*
1/9/98	0	0	160	3600	0.0444	0.0000	0.0000	0.0000	0.0000
1/10/98	*	*	*	*	*	*	*	*	*
1/11/98	*	*	*	*	*	*	*	*	*
1/12/98	0	0	200	3600	0.0556	0.0000	0.0000	0.0000	0.0000
1/13/98	*	*	*	*	*	*	*	*	*
1/14/98	0	1	140	2160	0.0648	0.0000	0.0000	0.0423	0.0302
1/15/98	0	0	200	1440	0.1389	0.0000	0.0000	0.0000	0.0000

TABLE 8. COLEMAN LATE-FALL CHINOOK RECOVERIES AT CHIPPS ISLAND
DELTA RELEASE - JANUARY 1998

DATE	NUM REC G.S.	NUM REC RYDE	TOW TIME (MINS)	TOTAL MINS	% SAMP	ALTER- NATIVE INDEX G.S.	USFWS INDEX G.S. .1348	ALTER- NATIVE INDEX RYDE	USFWS INDEX RYDE .1348
1/14/98	0	0	140	1440	0.0972	0.0000	0.0000	0.0000	0.0000
1/15/98	0	0	200	1440	0.1389	0.0000	0.0000	0.0000	0.0000
1/16/98	0	4	200	1440	0.1389	0.0000	0.0000	0.0753	0.0775
1/17/98	0	22	200	1440	0.1389	0.0000	0.0000	0.4139	0.4265
1/18/98	1	10	200	1440	0.1389	0.0138	0.0142	0.1882	0.1939
1/19/98	6	8	200	1440	0.1389	0.0828	0.0853	0.1505	0.1551
1/20/98	2	1	200	1440	0.1389	0.0276	0.0284	0.0188	0.0194
1/21/98	2	1	200	1440	0.1389	0.0276	0.0284	0.0188	0.0194
1/22/98	0	1	100	1440	0.0694	0.0000	0.0000	0.0376	0.0194
1/23/98	1	0	200	1440	0.1389	0.0138	0.0142	0.0000	0.0000
1/24/98	2	0	200	1440	0.1389	0.0276	0.0284	0.0000	0.0000
1/25/98	1	0	200	1440	0.1389	0.0138	0.0142	0.0000	0.0000
1/26/98	1	0	200	1440	0.1389	0.0138	0.0142	0.0000	0.0000
1/27/98	0	0	200	1440	0.1389	0.0000	0.0000	0.0000	0.0000
1/28/98	0	0	200	1440	0.1389	0.0000	0.0000	0.0000	0.0000
1/29/98	0	0	200	1440	0.1389	0.0000	0.0000	0.0000	0.0000
1/30/98	0	0	200	1440	0.1389	0.0000	0.0000	0.0000	0.0000
1/31/98	0	0	200	1440	0.1389	0.0000	0.0000	0.0000	0.0000
2/1/98	0	1	200	1440	0.1389	0.0000	0.0000	0.0188	0.0194
2/2/98	1	0	200	1440	0.1389	0.0138	0.0142	0.0000	0.0000
2/3/98	1	0	200	1440	0.1389	0.0138	0.0142	0.0000	0.0000
TOTAL	18	48	4040	30240	0.1336	0.2484	0.2559	0.9220	0.9305

TABLE 9. COLEMAN LATE-FALL CHINOOK RECOVERIES AT CHIPPS ISLAND
DELTA RELEASE - DECEMBER 1998

DATE	NUM REC G.S.	NUM REC RYDE	TOW TIME (MINS)	TOTAL MINS	% SAMP	ALTER- NATIVE INDEX G.S.	USFWS INDEX G.S. .1257	ALTER- NATIVE INDEX RYDE	USFWS INDEX RYDE .1105
12/1/98	0	0	157	1440	0.1090	0.0000	0.0000	0.0000	0.0000
12/2/98	0	0	200	1440	0.1389	0.0000	0.0000	0.0000	0.0000
12/3/98	0	0	200	1440	0.1389	0.0000	0.0000	0.0000	0.0000
12/4/98	0	3	200	1440	0.1389	0.0000	0.0000	0.0551	0.0693
12/5/98	0	9	200	1440	0.1389	0.0000	0.0000	0.1654	0.2079
12/6/98	0	6	200	1440	0.1389	0.0000	0.0000	0.1103	0.1386
12/7/98	1	3	220	1440	0.1528	0.0118	0.0143	0.0501	0.0693
12/8/98	0	2	200	1440	0.1389	0.0000	0.0000	0.0368	0.0462
12/9/98	2	2	200	1440	0.1389	0.0259	0.0286	0.0368	0.0462
12/10/98	0	0	200	1440	0.1389	0.0000	0.0000	0.0000	0.0000
12/11/98	0	1	200	1440	0.1389	0.0000	0.0000	0.0184	0.0231
12/12/98	1	0	200	1440	0.1389	0.0129	0.0143	0.0000	0.0000
12/13/98	0	0	200	1440	0.1389	0.0000	0.0000	0.0000	0.0000
12/14/98	0	0	200	1440	0.1389	0.0000	0.0000	0.0000	0.0000
12/15/98	1	0	200	1440	0.1389	0.0129	0.0143	0.0000	0.0000
12/16/98	0	1	200	1440	0.1389	0.0000	0.0000	0.0184	0.0231
12/17/98	0	0	120	1440	0.0833	0.0000	0.0000	0.0000	0.0000
12/18/98	0	0	60	1440	0.0417	0.0000	0.0000	0.0000	0.0000
12/19/98	1	0	200	1440	0.1389	0.0129	0.0143	0.0000	0.0000
12/20/98	1	0	200	1440	0.1389	0.0129	0.0143	0.0000	0.0000
12/21/98	1	0	200	1440	0.1389	0.0129	0.0143	0.0000	0.0000
12/22/98	0	0	200	1440	0.1389	0.0000	0.0000	0.0000	0.0000
12/23/98	2	0	200	1440	0.1389	0.0259	0.0286	0.0000	0.0000
12/24/98	0	0	200	2160	0.0926	0.0000	0.0000	0.0000	0.0000
12/25/98	*	*	*	*	*	*	*	*	*
12/26/98	0	0	130	2160	0.0602	0.0000	0.0000	0.0000	0.0000
12/27/98	0	0	200	1440	0.1389	0.0000	0.0000	0.0000	0.0000
12/28/98	0	0	200	1440	0.1389	0.0000	0.0000	0.0000	0.0000
12/29/98	0	0	60	1440	0.0417	0.0000	0.0000	0.0000	0.0000
12/30/98	0	0	190	1440	0.1319	0.0000	0.0000	0.0000	0.0000
12/31/98	0	0	200	1440	0.1389	0.0000	0.0000	0.0000	0.0000
1/1/99	1	0	200	1440	0.1389	0.0129	0.0143	0.0000	0.0000
1/2/99	0	0	200	1440	0.1389	0.0000	0.0000	0.0000	0.0000
1/3/99	0	0	200	1440	0.1389	0.0000	0.0000	0.0000	0.0000
1/4/99	0	0	200	1440	0.1389	0.0000	0.0000	0.0000	0.0000
1/5/99	0	1	200	1440	0.1389	0.0000	0.0000	0.0184	0.0231
1/6/99	0	0	200	1440	0.1389	0.0000	0.0000	0.0000	0.0000
1/7/99	0	0	160	1440	0.1111	-0.0000	0.0000	0.0000	0.0000
1/8/99	0	0	180	2160	0.0833	0.0000	0.0000	0.0000	0.0000
1/9/99	*	*	*	*	*	*	*	*	*
1/10/99	0	0	200	2160	0.0926	0.0000	0.0000	0.0000	0.0000
1/11/99	0	0	190	1440	0.1319	0.0000	0.0000	0.0000	0.0000
1/12/99	0	0	200	1440	0.1389	0.0000	0.0000	0.0000	0.0000

TABLE 10. COLEMAN LATE-FALL CHINOOK RECOVERIES AT CHIPPS ISLAND
DELTA RELEASE - LATE DECEMBER 1998

FIGURE 1

